Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	CS561	Title of the Course	Robot Kinematics and Dynamics	L	T	P	C
Year	I	Semester	I	3	1	0	4
Pre-Requisite	None	Co-requisite	None				
Course Objectives	This course provides the basics for deriving kinematic/dynamical models of a robot (such as a factory robotic arm, mobile robot, drone, etc.) and for designing robot controllers. Students will learn how to derive the equations of motion and basic control equations themselves, and they will also learn how to use existing frameworks to do the same.						

Course Outcomes	
CO1	Derive the equations of motion for different types of robots
CO2	Create joint-level and endpoint-level controllers (including trajectory following)
CO3	Implement a simulation model in Python or MATLAB
CO4	Analyses the designed control systems and reflect on the design choices

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction:**	Importance of the course and the big picture, Motivation with videos of examples, Connection to real world, Homogenous coordinates, quaternions. Recap of Control Theory: State-space model, root locus, bode plot, PID control, Concept of LQR and MPC control	7	1
2	**Endpoint Control for Robotic Manipulators:**	Big picture + motivation, Difference between position and torque-controlled robots, Position control (with a PID controller), Impedance control (for position tracking tasks), Force control (for force tracking tasks)	8	2
3	**Robot Arm Kinematics:**	Deriving forward kinematics and Jacobian (for a 2-DoF planar arm), Transformations between endpoint and join space using Jacobian, Kinematic singularities and solution, Kinematic task priority control (for a 3-DoF planar arm), Denavit-Hartenberg convention (just an introduction), Mention parallel robots and examine differences	8	3
4	**Robot Arm Dynamics:**	Rigid-body dynamics model, how to derive dynamics model with Lagrange method for 2-DoF arm, Using the dynamics model in the control, Dynamic task priority control	9	4
5	**Kinematics & Dynamics of Mobile Robot:**	Forward kinematic models: Wheel kinematic constraints, Robot kinematic constraints, non-holonomic system, Derivation of linear bicycle model, Steady-state analysis. Dynamics & Control of Mobile Robot / Automated Vehicle: Transient analysis, Frequency response, Path-following control, Drone Robots: Dynamics of quadrotor (drone) robots, Control of quadrotor (drone) robots	8	5

Reference Books:

1. Lynch, K. M., & Park, F. C. (2017). Modern robotics. Cambridge University Press.
2. Siciliano, B., Sciavicco, L., Villani, L., &Oriolo, G. (2010). Robotics: modelling, planning and control. Springer Science & Business Media.
3. Craig, J. J. (2009). Introduction to robotics: mechanics and control. Pearson Education India.
4. Ogata, K. (2010). Modern control engineering. Prentice hall.
5. Dorf, R. C., & Bishop, R. H. (2001). Modern Control Systems: Solutions Manual (Vol. 12). Prentice Hall.
6. Corke, Peter. “Robopy”, Python toolbox for robotics.
7. Foote, Tully. "tf: The transform library." 2013 IEEE Conference on Technologies for Practical Robot Applications (TePRA). IEEE, 2013.

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	1	2	1	1	1	1	1	1	1	1	1	1	2	1	1
CO 2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO 3	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1
CO 4	2	2	2	1	1	1	1	1	1	2	2	3	3	3	1
CO 5															

3 Strong contribution, 2 Average contribution , 1 Low contribution

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**CS563**	**Title of the Course**	**Robot Software Practical**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	**I**	**0**	**0**	**4**	**2**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	This course teaches students the basics for creating and collaborating on academic robotics software. It aims to give students sufficient knowledge and experience such that they can proceed learning more about robotics programming by themselves as needed. The course does this by providing an overview of key technologies, and letting students develop basic skills often used in real world robotic software development. The main objective is to obtain hands-on experience - beginner's level - with Linux, Git&Gitlab, C++, ROS, and integrate with common external libraries such as OpenCV and PCL. This course does not teach new robotics theory (e.g., perception, planning, control, etc.) which is covered in other courses.						

Course Outcomes	
CO1	use the command line on a Linux system, perform basic file operations and job management tasks, and automate tasks with shell scripts;
CO2	use Git to commit and integrate incremental code changes together with a lab partner, and resolve any code integration conflicts; use a Gitlab server to exchange code changes, and use its issue tracker to provide and receive feedback on each other's code;
CO3	solve programming tasks in C++, compile the code using Make, debug compile-time, link-time and run-time problems;
CO4	create new C++ ROS packages, use common ROS development tools, and utilize the ROS API in their C++ programs; investigate and integrate external libraries into their own ROS components, such as OpenCV or PCL;
CO5	add code comments and basic documentation to their code, find and interpret documentation of external libraries;
CO6	develop evaluative judgments on the quality of your own work and of the performance of others (including peers) by implementing and providing feedback; collaborate and coordinate with lab partners on coding tasks.

S. No.	List of Experiments	Contact Hrs.	Mapped CO
1	**Introduction to Linux:** Although Windows is the most prevalent operating system on desktop PCs, Linux became very popular for embedded systems such as robots. Developing for embedded Linux systems is most easily done in Linux itself, and this course aims to familiarize students with the use of Linux on the desktop and terminal. It includes the following topics: OS architecture, File system, Shell, Scripting.	8	1
2	**GIT/Gitlab:** All exercises will be submitted using Git, a widely used version control system to manage and collaborate on coding projects. During the course, students will practice basic tasks with git, such as solving code conflicts, and merging the work of lab partners. Using an issue tracker and giving constructive feedback to peers.	8	2
3	**C++:** C++ is one of the most relevant programming languages for robotics. Being an object-oriented language brings great advantages compared to its predecessor C. This gives students practical knowledge on C++ programming. The course encompasses the following topics: Introduction to C++, common compilation tools, basic programming in C++, classes and objects.	8	3
4	**ROS:**ROS: The Robot Operating System (ROS) is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behaviour across a wide variety of robotic platforms. During the course, students will learn to use existing ROS tools, create their own software components in C++, integrate them into an application, and test their solutions using a physics simulator.	8	4
5	**OpenCV or PCL:**You will also get some practice using external libraries in your robotics project, such as OpenCV or PCL. OpenCV is a computer vision library designed for computational efficiency and with a strong focus on real-time applications. The Point Cloud Library (PCL) is an open-source project for point cloud processing. Note that this course is *not* about understanding the methods or theory on which these libraries are based, but rather on integrating the provided functionality in novel software components.	8	5

Reference Books:

1. 1A Gentle Introduction to ROS", Jason M. O'Kane. http://www.cse.sc.edu/~jokane/agitr/

PO-PSO / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	1	1	1	2	1	2	2	1	1	1	1	
CO2	1	2	2	1	1	1	3	1	2	1	1	2	1	1	
CO3	1	2	2	1	1	1	2	1	2	2	1	2	1	2	2
CO4	1	3	3	1	2	1	3	1	2	2	1	2	2	2	
CO5	1	1	1	2	2	1	3	2	2	1	1	1	1	1	
CO6	1	1	1	2	2	2	3	1	3	2	1	1	1	1	

3 Strong contribution, 2 Average contribution , 1 Low contribution

Integral University, Lucknow

Effective from Session: 2018-2019							
Course Code	**CS-546**	**Title of the Course**	**Mathematical Programming**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	**I**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	1. Introduction to linear optimization and its extensions emphasizing the underlying mathematical structures, geometrical ideas, algorithms and solutions of practical problems. 2. how different formulations and algorithms can be combined to efficient solution methods 3. theory about linear programming, integer programming, and heuristics 4. knowledge about many different models and when they can be good starting points for modeling richer problems 5. solving real world problems, problems with computer software, discrete optimization formulations and algorithms						

Course Outcomes	
CO1	understand how commercial software for solving optimization problems works
CO2	understand how different ways to formulate optimization problems can affect the practical solvability of the problem
CO3	assess when optimization models might be solved by exact methods and when heuristics are needed
CO4	structure technical problems so that they can be formulated as mathematical programs
CO5	understand the pros and cons of different formulations and solution methods and the interaction between model and method

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Mathematical Foundation**	Basic Theory of Sets and Functions: Sets, Vectors, Sequences of Subsequences, Mapping and Functions, Continuous Functions; Vector Spaces; Matrices and Determinants; Linear Transformation and Rank; Convex Sets and Convex Cones, Convex and Concave Functions.	8	1
2	**Linear Programming**	Definitions and Terminologies, Basic Solutions of Linear Programs, Fundamental Properties for Linear Programs; Simplex Methods: Theory of Simplex Methods, Method of Computation Replacement Operation; Degeneracy in Linear Programming: Charnes' Perturbation Method.	8	2
3	**Duality in Linear Programming**	Cannonical Dual Programs and Duality Theorems, Equivalent Dual Forms, Lagrange Multipliers and Duality, Duality in the Simplex Method; Bounded Variable Problems; Transportation Problems; Assignment Problems.	8	3
4	**Nonlinear and Dynamic Programming**	Constrained and Unconstrained Optimization, Kuhn- Tucker Optimality Conditions; Quadratic Programming: Wolfe's Method, Dantzig's Method, Beale's Method, Lemke's Complementary Pivoting Algorithm.	8	4
5	**Methods of Nonlinea r Programming**	Separable Programming, Kelley's Cutting Plane Method, Zouten dijik's Method of Feasible Direction, Rosen's Gradient Projection Method, Zangwill's Convex Simplex Methods, Dantzig's Method for Convex Programs; Goal Programming, Multiple Objective Linear Programming, Functional Programming.	8	5

Reference Books:

1. S. M. Sinha, —Mathematical Programming: Theory and Methods, Elsevier, 2005.
2. Steven Vajda —Mathematical Programming Courier Corporation, 2009.
3. Melvyn Jeter, —Mathematical Programming: An Introduction to Optimization, CRC Press, 1986.
4. A. Bachem, M. Grötsche, B. Korte, —Mathematical Programming, The State of the Art, Springer Science & Business Media, 2012

e-Learning Source:

https://onlinecourses.nptel.ac.in/noc23_cs11

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3				2						2			
CO2	2	2		3								2			
CO3	2	3										2			
CO4	2	2	3	1						2		2			
CO5	3	3		1		2				1		2			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	CS570	**Title of the Course**	Artificial Intelligence for Robotics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite		**Co-requisite**	None				
Course Objectives	To provide knowledge of Artificial Intelligence techniques and their application in robotics for perception, planning, and intelligent decision making.						

Course Outcomes	
CO1	Apply AI techniques for robotic perception and control.
CO2	Analyze machine learning methods for robotic applications.
CO3	Design intelligent robotic systems using planning and reasoning.
CO4	Develop AI-based solutions for autonomous robots.
CO5	Explore research trends in AI for robotics.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**State Space Analysis of Continuous System**	Introduction to Artificial Intelligence,. Role of AI in Robotics. History and evolution of AI-based robots 4. Intelligent agents and environments. Types of AI (Narrow AI, General AI) , Components of intelligent robotic systems	7	1
2	**State Equations, Controllability and Observability**	Knowledge representation , Sensors and perception using AI ,. Computer vision basics 4. Feature extraction techniques , Object recognition and classification , Introduction to neural networks	8	2
3	**Pole-Placement Design and State observer**	Introduction to Machine Learning , Supervised learning ,Unsupervised learning 4. Reinforcement learning ,. Learning from demonstration ,. AI-based decision making	8	3
4	**Non-linear Control System**	Path planning algorithms , Search algorithms (BFS, DFS, A*) .,Motion planning using AI 4. Intelligent control systems , Sensor fusion techniques,. Introduction to deep learning in control	9	3,4
5	**Lyapunov's Stability analysis**	Autonomous robots and systems ,. AI in drones and self-driving vehicles ,Human-robot interaction ,. Robotics in healthcare and industry , Ethical issues in AI robotics , Case studies and current research trends	8	4,5

Reference Books:

1. Artificial Intelligence: A Modern Approach – Stuart Russell & Peter Norvig
2. Probabilistic Robotics – Sebastian Thrun
3. Deep Learning – Ian Goodfellow
4. ROS Documentation (Online Resources)

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	1									2	1		
CO 2	3	3	2	1	2							2	2	1	
CO 3	3	3	3	2	2							2	3	2	
CO 4	3	3	3	2	3							3	3	2	
CO 5	2	2	1	3	1	2	2	3		1		1	2	1	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	**CS571**	**Title of the Course**	**Introduction to Robotics**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	**I**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	1. Understand fundamental concepts of robotics and automation 2. Learn basic robot kinematics and control principles 3. Gain exposure to sensors, vision, and programming 4. Explore real-world applications and trends						

Course Outcomes	
CO1	Apply AI techniques for robotic perception and control.
CO2	Analyze machine learning methods for robotic applications.
CO3	Design intelligent robotic systems using planning and reasoning.
CO4	Develop AI-based solutions for autonomous robots.
CO5	Explore research trends in AI for robotics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction to Robotics:**	Definition and scope of robotics ,History and evolution of robots ,Types of robots (industrial, service, mobile, humanoid) , Robot anatomy (links, joints, actuators, end-effectors) , Degrees of Freedom (DOF)	7	1
2	**Robot Kinematics:**	Introduction to kinematics ,. Forward kinematics (position & orientation), Inverse kinematics (basic concepts & simple solutions) ,Coordinate transformations, Homogeneous transformation matrices , Denavit-Hartenberg (D-H) parameters,Workspace analysis	8	2
3	**Robot Dynamics & Control:**	Robot Dynamics & Control:. Introduction to robot dynamics , Newton-Euler formulation (basic idea),Trajectory planning: i. Point-to-point motion ii. Continuous path motion , Motion control concepts ,. PID control (Proportional, Integral, Derivative), Stability and basic control strategies	8	3
4	**Sensors & Machine Vision:**	Sensors & Machine Vision:Types of sensors: i. Position sensors ii. Velocity sensors iii. Force/torque sensors,. Introduction to vision systems ,. Image processing basics: i. Filtering ii. Edge detection,. Object detection basics ,. Role of AI in robotics	9	4
5	**Robot Programming & Applications:**	Introduction to robot programming , Basic programming languages used in robotics ,Introduction to ROS (Robot Operating System) ,Industrial applications (manufacturing, healthcare, logistics),Autonomous robots (mobile robots, drones), Case studies and recent research trends	8	5

Reference Books:
1. Introduction to Robotics: Mechanics and Control – John J. Craig
2. Robotics: Modelling, Planning and Control – Bruno Siciliano
3. Robot Operating System (ROS) : Online Resources

PO-PSO / CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO 1	3	1				1						1	2		
CO 2	3	3	2	1								2	3		
CO 3	3	3	3	1	1							1	3		
CO 4	3	2	2	2	2							2	3	1	
CO 5	3	1	2	1	3	2	1					2	3	1	2

3 Strong contribution, 2 Average contribution , 1 Low contribution

Integral University, Lucknow

Effective from Session:2026-27							
Course Code	CS572	**Title of the Course**	**Advanced Python Programming Lab**	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**0**	**0**	**2**	**1**
Pre-Requisite	Basic Python Programming	**Co-requisite**	None				
Course Objectives	• To strengthen programming skills in Python with advanced concepts relevant to Artificial Intelligence, Machine Learning, and Robotics applications. • To impart practical knowledge of advanced Python libraries for data handling, visualization, and scientific computing. • To enable students to design and implement algorithms for data analysis, machine learning, and automation using Python. • To provide hands-on experience in integrating Python with modern frameworks and tools for robotics and AI applications. • To develop problem-solving, optimization, and debugging skills through advanced Python programming practices.						

Course Outcomes	
CO1	Recall and apply advanced Python data structures, functions, and modules for efficient programming.
CO2	Implement and analyze data handling using Pandas, NumPy, and file handling techniques for structured and unstructured data
CO3	Apply and implement data manipulation techniques using Pandas, including reading and writing diverse data formats, cleaning and preparing datasets, and performing exploratory data analysis through grouping, aggregation, and visualization.
CO4	Evaluate and implement machine learning algorithms, regression/classification models, and automation scripts using Python frameworks.
CO5	Design and develop advanced data visualization dashboards, integrate Python with robotics/AI frameworks, and optimize solutions for real-world applications.

PRACTICAL

S.No.	List of Experiments	Contact Hrs.	Mapped CO
1	Write Python programs using advanced data structures (sets, dictionaries, nested lists) and modular programming with custom functions using conditional logics.	2	CO1
2	Code a Python program that accepts a short sentence from the user and classifies it as either “greeting” or “non-greeting” based on simple keyword matching (e.g., “hello”, “hi”, “good morning”).	2	CO1
3	Write a Python program that asks the user to input three short sentences, stores them in a list, and then prints the length of each sentence, showing how text data can be prepared for AI models.	2	CO1
4	Perform data loading, cleaning, and transformation using Pandas and NumPy on large datasets. Implement CSV/JSON file handling and apply group-by, merge, and aggregation operations.	2	CO2
5	Write a Python program that loads a CSV file into a Pandas DataFrame, inspects the first few rows, rename selected columns, and handles missing values by either filling them with default values or dropping the incomplete rows.	2	CO3
6	Develop a Python program that loads a CSV file containing basic robot sensor readings such as distance and battery level into a Pandas DataFrame, displays the first ten rows, and replaces missing values with a default placeholder	2	CO3
7	Implement a Python program using Scikit-learn to classify images (e.g., handwritten digits from MNIST dataset) with k-Nearest Neighbor (k-NN).	2	CO4
8	Write a Python script to automate a robotics task — simulate obstacle detection and avoidance using conditional logic and sensor input arrays.	2	CO4
9	Create interactive visualizations using Matplotlib and Seaborn, including histograms, scatter plots, and heatmaps.	2	CO5
10	Develop a Python-based dashboard integrating data visualization with machine learning predictions.	2	CO5

Reference Books:

1. Wes McKinney, *Python for Data Analysis*, 3rd Edition, O’Reilly Media, 2022.
2. Jake VanderPlas, *Python Data Science Handbook*, 2nd Edition, O’Reilly Media, 2023.
3. Sebastian Raschka & Vahid Mirjalili, *Python Machine Learning*, 4th Edition, Packt Publishing, 2022.
4. Luciano Ramalho, *Fluent Python*, 2nd Edition, O’Reilly Media, 2022.

e-LearningSource:

- Python Official Documentation
- Scikit-learn Documentation
- NumPy & Pandas Tutorials
- SciPy Documentation
- Matplotlib & Seaborn Guides (matplotlib.org in Bing)

Course Articulation Matrix: (Mapping of COs with POs and PSOs)															
PO-PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	1	2	1	1	2	-	-	1	-	-	1	2	1	1	-
CO2	2	2	2	2	2	-	-	2	-	-	1	2	2	2	-
CO3	3	3	2	2	2	-	-	2	-	-	2	3	2	2	-
CO4	3	3	2	3	3	2	-	2	2		2	3	3	2	2
CO5	3	2	3	3	3	2	1	2	2		2	3	3	3	3

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2018-19							
Course Code	CS-544	**Title of the Course**	Machine Learning: Theory and Methods	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course curriculum helps to understand the various machine learning methods and approaches. It aims to model learning problems, neural networks, genetic modelling, hypothesis testing, Gibbs algorithm, Bayes theorem and Bayesian Classifiers, probability learning, clustering approaches, associative learning.						

Course Outcomes	
CO1	Know about the concepts of Learning Problems, Induction, Decision Tree
CO2	Know about the concepts of Neural Networks, Perceptrons, Genetic Algorithms, Boltzmann Machine.
CO3	Know about the concepts of Bayes theorem, Maximum Likelihood Method, Bayesian Classifier
CO4	Know about the concepts of K-means, clustering
CO5	Know about the concept of first order rule set, associative learning

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	Learning Problems Perspectives and Issues Concept Learning Version Spaces and Candidate Eliminations Inductive bias Decision Tree learning Representation Algorithm Heuristic Space Search.	8	1
2	**Neural Networks and Genetic Algorithms**	Neural Network Representation Problems Perceptrons Multilayer Networks and Back Propagation Algorithms Advanced Topics Genetic Algorithms Hypothesis Space Search Genetic Programming Models of Evaluation and Learning	8	2
3	**Bayesian and Computational Learning**	Bayes Theorem Concept Learning Maximum Likelihood Minimum Description Length Principle Bayes Optimal Classifier Gibbs Algorithm Naïve Bayes Classifier Bayesian Belief Network EM Algorithm Probability Learning Sample Complexity Finite and Infinite Hypothesis Spaces Mistake Bound Model.	8	3
4	**Instant Based Learning**	K- Nearest Neighbour Learning Locally weighted Regression Radial Basis Functions Case Based Learning.	8	4
5	**Advanced Learning**	Learning Sets of Rules Sequential Covering Algorithm Learning Rule Set First Order Rules Sets of First Order Rules Induction on Inverted Deduction Inverting Resolution Analytical Learning Perfect Domain Theories Explanation Base Learning FOCL Algorithm Reinforcement Learning Task Q-Learning Temporal Difference Learning.	8	5

Reference Books:

1. Tom M. Mitchell-Machine Learning, Tata McGraw Hill Education (India) Private Limited, 2013.
2. Ethem Alpaydin-Introduction to Machine Learning, (Adaptive Computation and Machine Learning), The MIT Press-2004.
3. Stephen Marsland-Machine Learning: An Algorithmic Perspective, CRC Press 2009

e-Learning Source:

https://nptel.ac.in/courses/106105152

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	1	2	1	2	2	3				2	1	2	1	2	1			
CO2	1	3	2	1	1		2	3		2	3	1	3	2				
CO3	3	3	2	2	1	2	2	2	3	1	1	2	2	1	2			
CO4	3	2	3	2	3	1	3	3	2	2	3	3	2	3				
CO5	3	3	1	3	1	2	3	3	1	2	1	2	1	2	1			

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	CS562	**Title of the Course**	Planning and Decision Making	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course provides an overview of motion planning and decision-making techniques and their practical application in robotics. Planning and Decision-making are critical components of autonomy in robotic systems. These components are responsible for making decisions that range from path planning and motion planning to coverage and task planning to taking actions that help robots understand the world around them better. This course studies underlying algorithmic techniques used for planning and decision-making in robotics and examines case studies in ground and aerial robots, mobile manipulation platforms and multi-robot systems. The students will learn the algorithms and implement them in a series of programming-based projects. In particular, we will first cover the fundamentals of planning (workspace, configuration space, representation of obstacles and robot models). We will then cover a broad set of methods, which include reactive methods and feedback control; discrete, combinatorial and probabilistic planning; planning under differential constraints; planning under uncertainty; learning in planning; and planning for multi-robot systems. Finally, we will briefly touch upon task assignment and vehicle routing.						

Course Outcomes	
CO1	Explain the role of Motion Planning and Decision-Making (PDM) in Robotics, and describe possible applications
CO2	Identify different classes of robotic systems, the associated mathematical models for their kinematics, dynamics and motion and the relevant spaces for PDM, such as the configuration and state spaces
CO3	Describe and compare algorithms for motion planning and decision-making of mobile robots and multi-robot systems, including reactive algorithms, optimization-based algorithms, combinatorial algorithms, sampling-based algorithms, learning-based methods and planning in belief space
CO4	Analyse a PDM problem, consider constraints, objectives and select the appropriate PDM methods to apply
CO5	Design and implement motion planners of moderate complexity to solve motion-planning tasks and navigate mobile robots
CO6	Perform PDM experiments, evaluate the results, and draw sound conclusions. present the findings of a PDM experiment clearly in a report using graphs and scientific English. Understand PDM experiments descriptions found in scientific literature, and reproduce results

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction**	Planning and Decision-making in Robotics, Autonomous mobile robots, Course organization, Map & obstacles' representation	8	1
2	**Fundamentals**	3D rotations, configuration space, algorithm properties, Differential constraints: recap of modeling & control of manipulators, ground robots, aerial robots	8	2
3	**Algorithms**	Graph-search fundamentals (depth/breadth first, Dijkstra, A*, heuristics), Combinatorial algorithms (cell decomposition, shortest-path roadmaps, motion primitives), Sampling-based algorithms (PRM, RRT, RRT*), Reactive algorithms: collision avoidance, potential fields, velocity obstacles, Kinodynamic planning	8	3
4	**Optimization based algorithms**	Trajectory optimization I (Fundamentals + Global), Trajectory optimization II (MPC fundamentals + Local), Formal methods (reachability analysis, logic), Planning under uncertainty I (fundamentals, MDP, value iteration, Belief space), Planning under uncertainty II (POMDP, continues belief space, CCMPC), Learning in planning (deep learning, reinforcement learning, IRL), Multi-robot motion planning (joint configuration, optimization-based, coverage), Task assignment (Hungarian, auction, linear program) [1/2], Vehicle routing	8	4

Reference Books:

1. Decisive: How to Make Better Choices in Life and Work by Chip Heath & Dan Heath

PO-PS O / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	2	-	2	-	-
CO 2	3	3	2	-	2	-	-	-	-	-	-	3	2	-
CO 3	3	3	3	2	2	-	-	-	-	-	-	3	3	2
CO 4	3	3	2	2	2	-	-	-	-	-	-	3	3	2
CO 5	3	3	3	3	3	-	-	-	2	2	-	3	3	3
CO 6	2	2	-	3	2	-	-	-	3	3	-	2	2	2

Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	CS540	**Title of the Course**	Advanced Human Computer Interaction	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Develop an awareness of the ways in which Human Computer Interaction theories, methods and techniques guide the development of advanced technologies. Study advanced techniques used to assess the needs of the users of technology. Develop an ability to use these techniques to inform the design and implementation of computer systems. Use research techniques to expand their knowledge of emerging HCI theory. Develop an understanding of the social and ethical issues related to working with people. Apply advanced concepts in HCI to guide research discussions and write research reports						

Course Outcomes	
CO1	Explain advanced concepts of Human-Computer Interaction (HCI) as they apply to the design of emerging technology
CO2	Analyse and apply HCI theories and methods that are drawn from the human sciences
CO3	Critically analyze international research projects from the field of HCI.
CO4	Convey ideas related to the field of HCI clearly and fluently in written assignments and through seminar presentations.
CO5	Apply your understanding of the user-centered design process to a specific problem area.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction:**	Introduction: Course objective and overview, Historical evolution of the field, Concept of usability - definition and elaboration, HCI and software engineering	7	1
2	**Interactive system design:**	Interactive system design (theory and practice): GUI design and aesthetics, Prototyping techniques, Model based Design and evaluation: Basic idea, introduction to different types of models, GOMS family of models (KLM and CMN-GOMS), Fitts' law and Hick Hyman's law, Model- based design case studies.	8	2
3	**Guidelines in HCI:**	Guidelines in HCI: Shneiderman's eight golden rules, Norman's seven principles, Nielsen's ten heuristics with examples of its use, Heuristic evaluation, Contextual inquiry, Cognitive walkthrough. Empirical research methods in HCI: Introduction (motivation, issues, research question formulation techniques) Experiment design and data analysis (with explanation of one-way ANOVA).	8	3
4	**Task modeling and analysis:**	Task modeling and analysis: Hierarchical task analysis (HTA), Engineering task models and Concur Task Tree (CTT). Dialog Design: Introduction to formalism in dialog design, design using FSM (finite state machines), State charts and (classical) Petri Nets in dialog design, Cognitive architecture: Introduction to CA, CA types, relevance of CA in IS design, Model Human Processor (MHP).	9	4
5	**Design -Case Studies:**	Design -Case Studies: Case Study 1- Multi Key press Hindi Text Input Method on a Mobile Phone Case Study 2 - GUI design for a mobile phone based Matrimonial. Case Study 3 - Employment Information System for unorganized construction workers on a Mobile Phone.	8	5

Reference Books:

1. Dix A., Finlay J. Abowd G. D. and Beale R. Human Computer Interaction, 3rd edition, Pearson Education,2005.
2. Preece J., Rogers Y., Sharp H., Baniyon D., Holland S. and Carey T. Human Computer Interaction, Addison-Wesley,1994.
3. B. Shneiderman; Designing the User Interface, Addison Wesley 2000 (Indian Reprint)

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	2	1	1	1	1	2	3	1	2	3	2	1	1	1
CO 2	1	2	3	1	2	2	2	1	2	1	2	1	1	1	1
CO 3	1	3	1	1	1	1	1		1	3	1	2	1	1	1
CO 4	3	1	2	2	1	1	2	3	1	1	1	1	3	1	1
CO 5	1	2	1	1	2	1	2	1	2	2	1	1	1	1	1

3 Strong contribution, 2 Average contribution , 1 Low contribution

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	CS527	Title of the Course	Advanced Real Time Systems	L	T	P	C
Year	I	Semester	II	3	1	0	4
Pre-Requisite	Microprocessor and AI	Co-requisite	None				
Course Objectives	Real-time embedded systems are enabling technologies for many current and future generation applications and are increasingly becoming pervasive. This course aims to provide a good understanding of both fundamental concepts and advanced topics in real-time systems and networks.						

Course Outcomes	
CO1	Derive the equations of motion Real-time scheduling and schedulability analysis
CO2	Formal specification and verification of timing constraints and properties
CO3	Development and implementation of new techniques to advance the state-of-the-art real-time systems
CO4	Analyse and designed real-time systems and networks
CO5	Knowledge about the course of dimensionality and various methods of dimensions reduction

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction:**	Definition, Structure, Typical Real Time Applications: Digital Control, High Level Controls, Signal Processing etc., Release Times, Deadlines, and Timing Constraints, Hard Real Time Systems and Soft Real Time Systems, Reference Models for Real Time Systems: Processors and Resources, Periodic Task Model, Critical and Non-critical tasks Precedence Constraints	8	1
2	**Real Time Scheduling of Uni-processor systems:**	Processor systems- Common Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems. Classical Uniprocessor Scheduling Algo-Rate Monotonic, EDF, Uniprocessor Scheduling of IRIS Tasks: Identical and Non identical Linear & Concave Reward Function, 0/1RewardFunction.	8	2
3	**Real Time Scheduling of Multi- Processor:**	Multiprocessor and Distributed System Model, Bin- Packing Assignment Algorithm for EDF, Next-Fit Algorithm for RM Scheduling, Myopic Offline Scheduling, FAB Algorithm & Buddy Strategy. Real Time Database: Real Time vs. General purpose Database, Main Memory database, Concurrency Control Issues.	8	3
4	**Real Time Operating Systems:**	An overview of RTOS, Real Time Threads, Tasks & Kernels, Case Study of QNX, VRTX, Vx Works. Fault Tolerance in Real Time Operating Systems- Introduction to Fault, Fault Detection and Error Containment, Redundancy, Data Diversity, Reversal Checks, Malicious & Integrated Failure Handling. Clock Synchronization: Introduction to Clocks.	9	4
5	**Real Time Communication:**	Design -Case Studies: Case Study 1- Multi Key press Hindi Text Input Method on a Mobile Phone Case Study 2 - GUI design for a mobile phone based Matrimonial. Case Study 3 – Employment Information Model of Real Time Communication, Medium Access Control Protocols for Broadcast Networks, Internet and Resource Reservation Protocols, Real Time Protocols, VTCSMA, Communication in Multicomputer System, N/W Topologies.for unorganized construction workers on a Mobile Phone.	8	5

Reference Books:

1. C.M. Krishna & Shin, "Real Time Systems", Mc Graw Hill1985.
2. Jane W.S. LIU, "Real Time Systems", Pearson Education".
3. Levi & Agarwal, "Real Time System", McGraw Hill.
4. Mall Rajib, "Real Time Systems", Pearson

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	-	2	-	-	-	-	-	-	-	3	-	2	-
CO 2	3	3	-	2	-	-	-	-	-	-	-	3	-	2	-
CO 3	2	2	3	3	2	-	-	-	2	-	-	2	3	2	2
CO 4	3	3	3	3	2	-	-	-	2	-	-	3	3	3	3
CO 5	2	3	3	3	2	-	-	-	-	-	-	2	2	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CS 523	**Title of the Course**	Pattern Recognition	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	1. To implement pattern recognition and machine learning theories. 2.To design and implement certain important pattern recognition techniques. 3. To apply the pattern recognition theories to applications of interest. 4. To implement the entropy minimization, clustering transformation and feature ordering. 5. To introduce the curse of dimensionality and various methods of dimensions reduction						

Course Outcomes	
CO1	Implementation of pattern recognition and machine learning theories.
CO2	Designing and implementing certain important pattern recognition techniques.
CO3	Applying the pattern recognition theories to applications of interest.
CO4	Implementation of the entropy minimization, clustering transformation and feature ordering
CO5	Knowledge about the curse of dimensionality and various methods of dimensions reduction

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction:**	Basic concepts, Applications, Fundamental problems in pattern Recognition system design, Design concepts and methodologies, Examples of Automatic Pattern recognition systems, Simple pattern recognition model. DECISION AND DISTANCE FUNCTIONS -Linear and generalized decision functions, Pattern space and weight space, Geometrical properties, implementations of decision functions, Minimum-distance pattern classifications.	8	1
2	**Probability:**	Probability of events: Random variables, Joint distributions and densities, Movements of random variables, Estimation of parameters from samples. STATISTICAL DECISION MAKING- Introduction, Baye's theorem, Multiple features, Conditionally independent features, Decision boundaries, Unequal cost of error, estimation of error rates, the leaving -one-out-techniques, characteristic curves, estimating the composition of populations. Baye's classifier for normal patterns.	8	2
3	**Non Parametric Decision Making:**	Introduction, histogram, kernel and window estimation, nearest neighbour classification techniques. Adaptive decision boundaries, adaptive discriminate functions, Minimum squared error discriminate functions, choosing decision making techniques. CLUSTERING AND PARTITIONING- Hierarchical Clustering: Introduction, agglomerative clustering algorithm, the single -linkage, complete-linkage and average -linkage algorithm. Ward's method Partition clustering-Forg's algorithm, K-means's algorithm, Isodata algorithm.	8	3
4	**Pattern Preprocessing And Feature Selection:**	Introduction, distance measures, clustering transformation and feature ordering, clustering in feature selection through entropy minimization, features selection through orthogonal expansion, binary feature selection.	8	4
5	**Syntactic Pattern Recognition & Application Of Pattern Recognition:**	Introduction, concepts from formal language theory, formulation of syntactic pattern recognition problem, syntactic pattern description, recognition grammars, automata as pattern recognizers, Application of pattern recognition techniques in bio-metric, facial recognition, IRIS scon, Finger prints, etc.	8	5
Reference Books:				
Richard duda, Hart, David Strok, "Pattern Classification", John Wiley.				
2. Digital Image Processing, M.Anji Reddy, Y.Hari Shankar, BS Publications.				
e-Learning Source:				
https://onlinecourses.nptel.ac.in/noc19_ee56/preview				

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	3	1	3	1	2	1	1	2	3	1	-	-
CO2	3	1	2	3	1	1			2		2	3	2	-	-
CO3	3	1	2	3	2	2	3		1		3	3	2	3	
CO4	3	1	2	3	3	3					2	3	1	3	
CO5	3	1	2	3	1	2	1				2	3	2		3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Control Systems for Robotics

Effective from Session: 2026-27							
Course Code	EE502	**Title of the Course**	Control Engineering	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	Microprocessor and AI	**Co-requisite**	None				
Course Objectives	1. To understand fundamental concepts of control systems used in robotics. 2. To develop knowledge of mathematical modeling of robotic systems. 3. To analyze system stability and performance. 4. To design controllers for robotic applications. 5. To explore real-world robotic control systems.						

Course Outcomes	
CO1	Analyze basic control system concepts and robotic system models.
CO2	Apply mathematical modeling and transfer functions to robotic systems.
CO3	Analyze stability and performance of control systems.
CO4	Design controllers for robotic systems.
CO5	Implement control strategies in real-world robotic applications.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Control Systems**	Introduction to control systems, Types of control systems (Open-loop and Closed-loop), Mathematical modeling of systems,Transfer function concept, Block diagrams and signal flow graphs,Applications in robotics	7	1
2	**System Modeling and Time Response**	Differential equations of systems,Laplace Transform and its applications,Time response of first-order systems,Time response of second-order systems, Step, ramp, and impulse responses, Performance specifications (rise time, settling time, overshoot)	8	2
3	**Stability Analysis**	Concept of stability,Routh-Hurwitz stability criterion , Root locus technique ,Frequency response basics,Introduction to Bode plot	8	3
4	**Control System Design**	Controllers: P, PI, PID,Tuning of PID controllers, Frequency domain design,Introduction to state-space representation,Control in robotic manipulators	9	3,4
5	**Advanced Control in Robotics**	Feedback control in robots, Motion and trajectory control,. Sensors and actuators in control systems, Introduction to intelligent control (fuzzy logic, adaptive control),Applications: Industrial robots, autonomous systems	8	4,5

Reference Books:

1. Modern Control Engineering – K. Ogata
2. Control Systems Engineering – Norman S. Nise
3. Feedback Control of Dynamic Systems – Gene F. Franklin
4. Robotics: Control, Sensing, Vision and Intelligence – K.S. Fu

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	-	-	-	-	-	-	-	2	-	3	-	2	-
CO 2	2	3	2	2	2	-	-	-	-	3	-	3	2	3	-
CO 3	3	3	2	2	-	-	-	2	-	3	-	3	3	2	-
CO 4	2	3	3	2	-	2	-	2	-	3	-	2	3	2	2
CO 5	3	2	3	3	2	2	2	3	3	3	2	3	3	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2026-27							
Course Code	CS573	**Title of the Course**	Edge AI and Embedded Systems	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	Microprocessor and AI	**Co-requisite**	None				
Course Objectives	To understand resource-constrained embedded systems and architectures. To develop expertise in ARM-based embedded platforms and programming. To introduce Edge AI, TinyML, and deployment frameworks. To design, optimize, and deploy AI models on embedded systems. To explore real-world applications of embedded AI systems.						

Course Outcomes	
CO1	Analyze embedded system architecture and ARM-based processors
CO2	Design and program embedded systems with real-time constraints.
CO3	Apply Edge AI and TinyML techniques for intelligent systems.
CO4	Optimize and deploy AI models on embedded platforms.
CO5	Develop application-oriented embedded AI solutions.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Embedded Systems Architecture and Design**	Introduction to Embedded Systems, Resource-Constrained Systems, Microcontrollers vs Microprocessors, ARM Cortex Architecture (Overview), Memory Organization, MPU, Embedded System Design Flow	7	1
2	**Embedded Programming and Real-Time Systems**	Embedded C Programming, Compiler & Linker Optimization, Interrupts and Exception Handling, RTOS Concepts: Scheduling, Synchronization, Interfacing: Sensors, Actuators, Communication: UART, SPI, I2C	8	2
3	**Embedded AI and TinyML**	Basics of Python: NumPy, TensorFlow, Introduction to TinyML and TensorFlow Lite, CNN Fundamentals, Model Training & Evaluation, Model Optimization: Quantization, Pruning, Weight Clustering, Embedded AI Development Lifecycle	8	3
4	**Edge AI Systems and Deployment**	Edge AI vs Cloud AI vs Fog Computing, Edge AI Architecture, Edge Hardware Platforms: Raspberry Pi, NVIDIA Jetson, Edge TPU. Deployment Frameworks: TensorFlow Lite , PyTorch Mobile Edge Inferencing & Data Processing, Industrial Edge AI Use Cases	9	3,4
5	**Optimization, Security and Applications**	Performance Optimization: Latency, Throughput, Energy Efficiency Security in Embedded AI Systems,, AI Accelerator Concepts (NPU, TPU) Applications: Smart Healthcare, Predictive Maintenance, Autonomous Systems Introduction to Contemporary Topics	8	4,5

Reference Books:

1. Ovidiu Vermesan, Mario Diaz Nava, Björn Debaillie, Embedded Artificial Intelligence: Devices, Embedded Systems, and Industrial Applications, CRC Press, 2023..
2. Daniel Situnayake, Jenny Plunkett, AI at the Edge: Solving Real-World Problems with Embedded Machine Learning, O'Reilly Media, 2023.
3. Bin Li, Embedded Artificial Intelligence: Principles, Platforms and Practices, Springer, 2024.
4. Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw Hill, 2017 (latest widely used edition).

PO-PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	-	-	-	-	-	-	-	2	-	3	-	2	-
CO 2	2	3	2	2	2	-	-	-	-	3	-	3	2	3	-
CO 3	3	3	2	2	-	-	-	2	-	3	-	3	3	2	-
CO 4	2	3	3	2	-	2	-	2	-	3	-	2	3	2	2
CO 5	3	2	3	3	2	2	2	3	3	3	2	3	3	2	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	CS531	**Title of the Course**	Seminar	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	2	1
Pre-Requisite	NIL	**Co-requisite**	NIL				
Course Objectives	● To understand the organization of topics for presentation and research. ● To learn the skill set required to perform research.						

Course Outcomes	
CO1	Skill to search on any topic to extract the inference.
CO2	Ability to organize – deliver presentations and report on any topic.

Unit No.	Content of Unit	Contact Hrs.	Mapped CO
1	Seminar shall be delivered preferably on the topic of dissertation or at least the area of dissertation. The concepts must be clearly understood and presented by the student. Prior to presentation, he/she shall carry out the detailed literature survey from Standard References such as International Journals and Periodicals, recently published reference Books etc. All modern methods of presentation should be used by the student. A hard copy of the report (25 to 30 pages) should be submitted to the Department before delivering the seminar. A PDF copy of the report in soft form must be submitted to the supervisor along with other details if any. Supervisor should guide concern student 2hrs /week/student for seminar.	03hrs	CO1 and CO2

	Course Articulation Matrix: (Mapping of Cos with Pos and PSOs)													
PO-PSO / CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	0	0	0	3	3	1	2	1	3	3	0	3	3	3
CO2	0	0	0	0	3	1	2	1	3	3	0	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2020-21								
Course Code	CS-549	**Title of the Course**	Machine Learning Tools Lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**0**	**0**	**2**	**1**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To learn the basic concepts of programming for machine learning. To be able to develop logics which help them to create machine learning programs and applications using Python language. To analyze the datasets using supervised as well as unsupervised algorithms. To learn the training and testing phases of machine learning. After understanding machine learning they can easily switch and analyze various problems.						

Course Outcomes	
CO1	Able to understand the basic concepts of programming for machine learning.
CO2	Able to design and develop various machine learning programming problems using Python programming concepts.
CO3	Able to analyze and develop machine learning programs and applications.
CO4	Able to develop programs for diverse datasets, domains and dimensionality.
CO5	Able to draw inferences from analyzed dataset.

S. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
	Supervised Learning:		
1	Simple Regression	2	1
2	Logical Regression	2	1
3	Gradient Descent and Cost Function	2	1
4	Logistic Regression (Binary Classification)	2	2
5	Logistic Regression (Multiclass Classification)	2	2
6	Decision Tree Method	2	2
7	Support Vector Machine (SVM)	2	3
8	Random Forest Method	2	3
9	K Fold Cross Validation	2	3
	Unsupervised Learning:		
1	K Means Clustering Algorithm	2	4
2	Naive Bayes Classifier	2	4
3	K nearest neighbors' classification	2	5
4	Principal Component Analysis (PCA)	2	5
e-Learning Source:			
https://nptel.ac.in/courses/106105152			

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	3		2		2						2	2	1	
CO2	2	2	1	1			3						2	2	2	
CO3	2	1	1	1			1						2	1	1	
CO4	1	1		2		2	2						2	2	1	
CO5	1	1	1				2						2	3	2	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	CS-529	**Title of the Course**	Digital Image Processing and Its Applications	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To explain basics of digital signal processing such as Fourier analysis To expose students to different low level image processing tasks such as filtering, edge detection etc. To impart knowledge of image compression as well as various image Segmentation techniques. To introduce advanced image processing algorithms for face detection and recognition.						

Course Outcomes	
CO1	Explain basic image processing techniques for solving real problems.
CO2	Apply image processing techniques for solving problems in computer science.
CO3	Develop understanding for object registration and recognition
CO4	Develop an application using existing image processing algorithms
CO5	Evaluate algorithms for higher level image processing.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Digital Image Fundamentals**	Image Sensing, and Acquisition, Image Sampling and Quantization, Basic Relationship between Pixels. Sensor and Imaging: Imaging Optics, Radiometry of Imaging, illumination sources and techniques, Camera Principles, Color Imaging, Single Sensor Color Imaging and Color Demosaicing, Range Images,3DImaging.	8	1
2	**Signal Representation**	Vector Space and Unitary Transforms, Multi-Resolutional Signal Representation, Wave let Decomposition, Scale space and diffusion, Representation of color, Retinex Processing, Markov Random Field Modellings of Images	10	2
3	**Non-linear Image Processing**	Median and Order Statistics Filters, Rank-Ordered-Mean Filters and Signal Dependent Rank-Ordered-Mean Filters, Two Dimensional Trager Filters, Applications of nonlinear filters in image enhancement, edge detections, noise removal etc.	8	3
4	**Image Processing in Biometric Security**	Introduction, Fingerprint Recognition, Face Recognition, Iris Recognition, Vein Pattern Recognition, Multimodal Biometrics Techniques. Biometric System Architecture, Extraction Algorithm, Matching Algorithm, Authentication, Biometric System Evaluation, Privacy issues.	8	4
5	**Image Processing in Medical Field**	Image Processing in Medical Field: Introduction, CT scan images, MRI, Seeded segmentation methods: Desirable properties, Pixel Based Methods, Contour Based Methods, Geodesic Active Contours, level set method, deformable model, graph based method, Image analysis of retinal images :acquisition, preprocessing	10	5

Reference Books:

1. R.C Gonzalez and R.E. Woods, “Digital Image Processing" , Addison Wesley, 1992.
2. A.K.Jain, “Fundamentals of Digital Image Processing” , Prentice Hall of India.
3. Digital Image Processing–M. Anji Reddy, BS Publications.

e-Learning Source:

https://nptel.ac.in/courses/117105135

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2	1	3		1	3	1		1	1	2		2	2	1			
CO2	3	2	3		1	1			2		2		1	3				
CO3	2	2	1		2	2	3		1		3		1		3			
CO4	3	2	2		3	3					2				3			
CO5	3	1	1		1	2	1				2					3		

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation